The South Parish Tree Audit

Final Report

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1. Introduction

Increasing urbanisation (the formation of dense settlements by humans) is transforming land use around the globe. More than 50% of the world's population live in cities and this figure is expected to rise to 60% by 2030 (Pickett *et al*., 2011). Urbanisation changes the physical environment by increasing impermeable surface cover, elevating noise, air and light pollution and causing higher temperatures (Johnson and Munshi-South, 2017). Trees can help to combat these negative effects, providing a wide range of benefits. These benefits are often poorly understood; therefore, people do not fully appreciate the roles that trees play in our cities and can often disregard them. Examining some of these benefits will allow us to fully comprehend and communicate to others the importance of having trees in urban areas.

Cork City Council declared a climate change and biodiversity emergency in 2019. It is recognised that green infrastructure plays a significant role in tackling these two interlinked crises as well as developing an attractive, liveable and sustainable city. Indeed the Cork City Green and Blue Infrastructure (GBI) Study refers to trees as a *'fundamental building block of any GBI network'* (Cork City Green and Blue Infrastructure Study, 2021).

An analysis by Bluesky International estimates that the tree canopy coverage within Cork City is 14% and that there is an imbalance in the distribution of the trees across the city and that street tree deficits are associated with areas of known economic deprivation (Cork City Green and Blue Infrastructure Study, 2021; Figure 1.1).

The South Parish Tree Audit Project set out to record all trees within the parish boundaries and to provide more detail than that which is possible from tree canopy analysis. Through recording each tree in this manner, it is hoped that the findings presented here can contribute to the greater understanding of the role urban trees play in our cities; how the tree community is structured in terms of species, level of maturity, etc.; how the trees can contribute to carbon sequestration and storage; and how we can plan for future, healthy tree communities in the South Parish and other areas of the city.

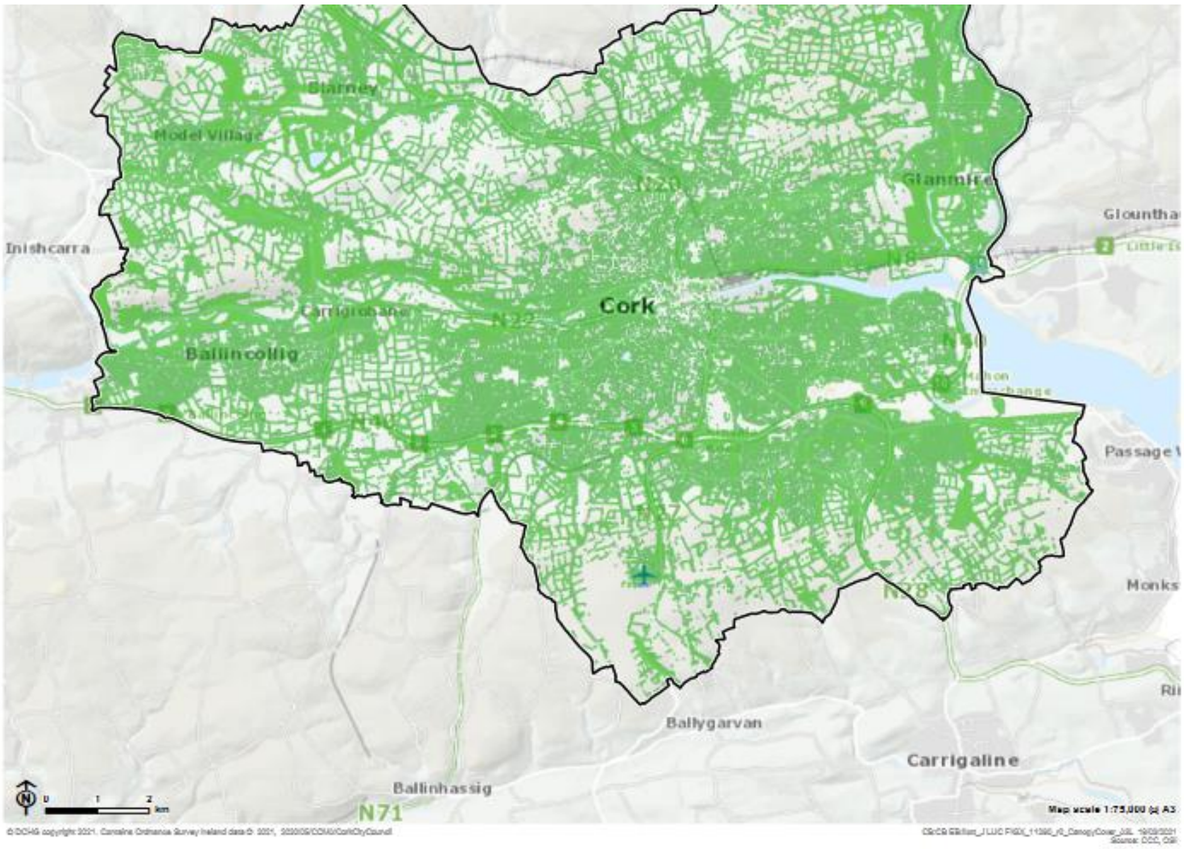

Figure 1.1: Existing Cork city tree canopy coverage (Bluesky International National Tree Map; Cork City Green and Blue Infrastructure Study, 2021).

1.1 Benefits of Urban Trees

Ecosystem service potentials of urban trees include: managing storm water and reducing flooding through the uptake of water in the root system and intercepting rainfall in the tree canopy (Livesley *et al.,* 2016); air pollution removal and air quality regulation (Jim and Chen, 2009, Baró *et al.,* 2014) which in turn leads to improved human health (Nowak *et al.,* 2014) and temperature reduction (Livesley *et al*., 2016). Urban trees help to increase and protect biodiversity by providing a habitat for wildlife, particularly birds and invertebrates. For example, trees such as sycamore, willow and hawthorn are a great source of pollen for bees in the summer months (Donkersley, 2019). Trees provide shade to buildings during the summer to help reduce costs of air conditioning but are also beneficial in the winter months when they lose all their leaves, allowing more sunlight into buildings when it is needed most, thereby reducing the need for heating (McPherson and Simpson, 1999). This reduction in demand for the production of electric power is one way in which urban trees can reduce carbon emissions.

One of the most widely reported benefits of trees in an urban setting is that of carbon storage and sequestration, which will be examined in greater detail. Trees also contribute to the visual quality of the landscape (Helliwell, 2008), without trees our cities would be grey and lifeless, they help to break up the monotony of the urban landscape. Some benefits of urban trees are summarised in Figure 1.2.

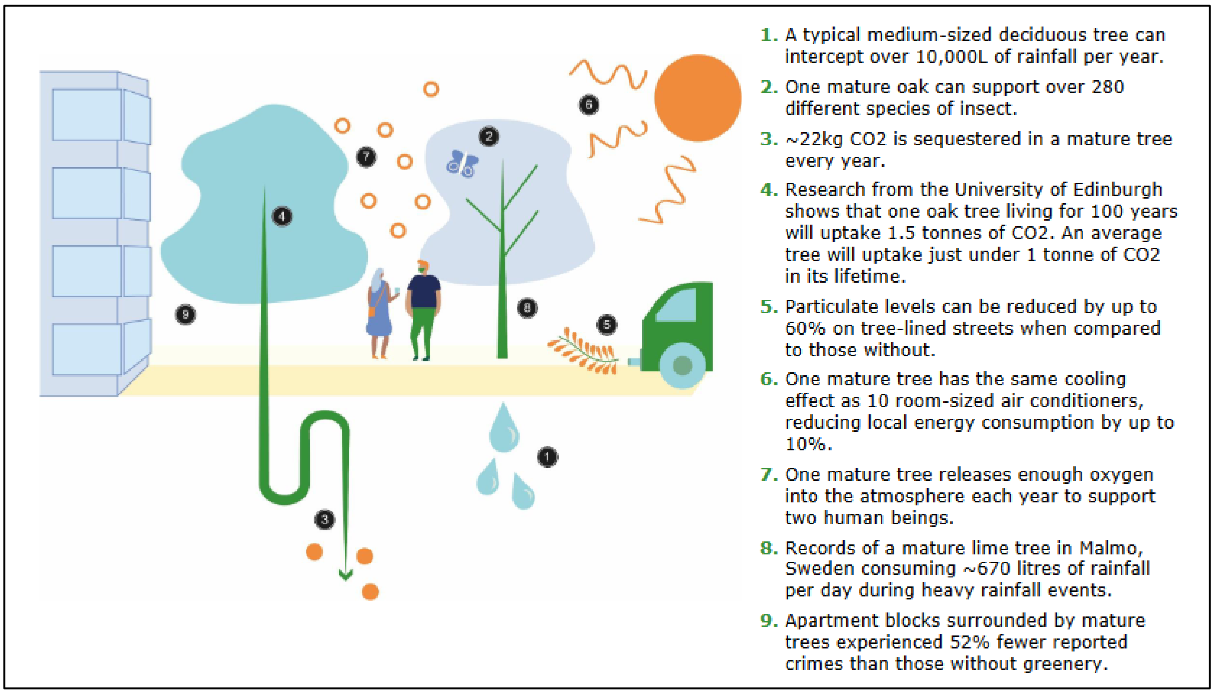

Figure 1.2: Some benefits of urban trees (Cork City Green and Blue Infrastructure Study, 2021).

1.2 Visual Amenity of Trees

Different trees make different contributions to the visual quality of an area. Trees can enhance the attractiveness of a townscape in many ways. In urban areas, the scenery is mostly 'artificial', consisting of buildings, bridges and roadways. Trees can help to add a sense of naturalness to the area and provide detail to a simple town structure (Helliwell, 2008). They capture light and provide an array of different colours, from greens in the summer to yellows, oranges and reds in the autumn. This helps to create interest, beauty and character in an otherwise dull and lifeless city. Studies have shown that people plant trees mainly for aesthetic reasons (Conway, 2016). People are often dissatisfied with their neighbourhoods because of the lack of attractiveness due to the absence of trees (Gwedla and Shackleton, 2019). Trees can also help to hide unattractive items in an urban setting, such as parked cars, signs and unsightly buildings. In some places, trees may actually be the principle feature of a public area, where special events take place and the tree is of great importance to the local people. Trees in urban areas have a great visual importance because there are so many people passing by each day to appreciate them, unlike in woodland and countryside areas where few people get to see the trees. The aesthetic value of trees makes people more likely to choose active modes of transport, such as walking or cycling, rather than driving (Handy *et al.,* 2002). This subsequently leads to better human health and reduced carbon emissions from vehicles. Of course, some trees may not possess any visual amenity value if they are planted in an unsuitable place and actually detract from the landscape (Helliwell, 2008). This is why it is important to carefully consider which tree species should be planted in an area and to not just plant any tree in any location. Different trees will suit different settings and it is crucial to incorporate this when planning. There is no point planting a tree somewhere if it is going to cause problems in a few years' time and will then likely be cut down.

1.3 Trees and Carbon Sequestration

Carbon dioxide (CO_2) is a greenhouse gas and the majority of the world's CO_2 is being emitted from cities through fossil fuel burning (Escobedo *et al.,* 2011). The reduction of these emissions poses a significant challenge to cities worldwide. One potential solution to this problem is tree planting and maintenance. Carbon sequestration is the fixation of carbon by trees through the process of photosynthesis and excess carbon is then stored as biomass in the trunk, leaves, branches and roots (Nowak and Crane, 2002). It refers to the annual rate at which carbon is removed from the atmosphere and stored as tree biomass during one growing season (McPherson, 1998). The rate at which a tree sequesters carbon depends on a number of factors such as its species, size and age. In general, larger trees tend to remove and store more carbon than smaller trees due to their greater canopy area and trunk diameter (Brack, 2002, Stephenson *et al.,* 2014). However, carbon sequestration usually reaches a peak and may then start to decline when the tree has reached its maximum size and growth rate decreases. This is species-dependent, however. Some studies have found that carbon sequestration increases with increasing age of the tree, with the youngest trees sequestering the least amount of carbon (Hand *et al.,* 2019a, Hand *et al.,* 2019b).

1.4 Biodiversity

Biodiversity is under threat from the constant growth of urban areas. By the year 2030, urban land cover is predicted to be triple what it was in 2000 (Seto et al., 2012). It is necessary to grow native tree species to retain the natural biodiversity of an area and, internationally, there are government initiatives in place to plant trees in urban areas along streets, in parks, in gardens, and on roofs (Tzoulas et al., 2007). These plans have as an objective to help reduce the loss of biodiversity. However, urban areas tend not to have old, large trees with hollows or decaying logs that could act as useful habitats for insects, for example. The amount of vegetation and soil in urban areas determines the amount of biodiversity that can be supported.

Urban trees are important to bird species in particular. They provide a place to nest, food, and protection. Native trees in particular have many benefits for avian species (Wood et al, 2020). Indeed, one study in California suggested that non-native tree species have little benefit in feeding birds (Wood et al, 2020).

It is well understood that insects are extremely sensitive to temperature meaning that climate change could have both positive and negative effects on them. Milder winter temperatures could increase life expectancies of insects, while colder and wetter weather will decrease life expectancy (Pureswaran et. al, 2018).

Another common organism associated with urban trees, indeed trees in general, are lichens. These are made up of two or more organisms, a fungus and an algae or cyanobacteria. These organisms form a symbiotic relationship: the fungus requires food, which is made through photosynthesis by algae and algae requires shelter which is provided by fungus (Hale, 1967). They do not harm trees. Lichens are important for many reasons. They provide material to birds for nesting and small insects can live in them. They capture carbon through photosynthesis and produce oxygen. Lichens can be used to monitor air quality, as different lichens will only grow in specific air qualities and levels of pollution (Lutzoni et. al, 2009).

1.5 Methods of Valuation

The Helliwell System, which was first published in 1967, is the method that was used to value the visual amenity of trees in the South Parish. This system has been used in court cases, public enquiries and insurance claims (Helliwell, 2008). However, its main function here is to determine the importance of urban trees in the hope that it will encourage the planting of more trees not just in Cork City but in other cities too. The Helliwell System is quite subjective as one person's idea of a visually attractive tree may differ to someone else's. An alternative method, which was not used here, for valuing amenity trees is CAVAT (Capital Asset Value for Amenity Trees). This method calculates a compensation replacement value for trees (Doick *et al.,* 2018). While most other valuation methods assess the benefits of a tree by using its cost from a nursery as a basis, the Helliwell System does not (Helliwell, 2008). Using costs can give very different results from one country to the next. The Helliwell System was chosen here as the preferred method of evaluation because this study is only concerned with the benefits provided by trees and not the costs associated with planting and maintaining them. The Helliwell System also has lower field data requirements than other methods (Sarajevs, 2011) making it easier to work with. No system is perfect, including Helliwell, but it is a good option.

Another objective of this project was to calculate the amount of carbon dioxide sequestered by the trees in the South Parish using existing models. Due to the major issue of climate change, carbon sequestration is often believed to be an important benefit of urban trees. Different tree species and trees of different sizes are compared to see if certain trees outperform others in terms of benefits provided.

A set of surveys were also designed and distributed to gather information on people's perceptions of urban trees. The surveys aimed to discover whether or not the public are aware of the benefits urban trees provide and if they are interested in seeing more trees being planted in their city. It is important to ensure that the public are aware of and appreciate the importance of urban trees (Collins *et al.,* 2019).

It has been reported that larger, older trees provide more services than smaller, younger trees because the benefits of urban trees are proportionate to their size (Trees and Design Action Group, 2010). However, large urban trees are under threat because they are often deemed to pose a danger to society and are believed by some people to be a cause of buildings subsidence. Smaller varieties of trees are being planted more and they, of course, provide benefits too but are unlikely to reach old age and large sizes because they are so susceptible to the hostile urban environment. This project hopes to inform on which species are best suited for future planting and which are not worth the trouble.

1.6 Project Aims

The aim of this project was to investigate whether urban trees in the South Parish, Cork City, have a value and if so, what that value is. In addition to compiling a comprehensive database of trees in the South Parish, the investigation also aimed to answer the following questions:

- What is the visual amenity value of these trees? Do certain areas in the South Parish have higher values than others?
- How much carbon is being stored and sequestered by these trees?
- Do urban trees in the South Parish increase insect biodiversity in green spaces?
- What are the public's thoughts on urban trees and their benefits and disadvantages?

2. Methods

2.1 Study Area

This project was carried out in the South Parish area of Cork City, Ireland. The South Parish (Figure 2.1) is an historic residential and commercial quarter to the south of the River Lee's southern channel, starting from the quays (e.g. Union Quay, George's Quay, Sullivan's Quay). The boundary extends in the east from Eglington Street and the South City Link Road, up to St. Finbarr's Cathedral and Elizabeth Fort in the west, stretching as far as Connaught Avenue and University College Cork. The southern boundary runs along Summerhill South, Evergreen Street and Tower Street. The South Parish has an area of approximately 1.15 km² (measured using Google Maps). In recent years parts of the area have become degraded with a poor-quality public realm. Many of the trees in the South Parish are located in Institutions such as St. Finbarr's Cathedral and Nano Nagle Place but there are also trees located on the streets and in private gardens.

Figure 2.1: Aerial photo of the South Parish, Cork, showing the approximate boundaries used in the tree survey (South Parish Historical Society Cork Ireland, 2020).

2.2 Field Work and Tree Data Collection

Field work was carried out from Autumn 2019 to Autumn 2021. All COVID-related precautions and restrictions were adhered to and this meant that at some stages, field work was paused. TagOnMap (Figure 2.2), an online interactive map that allows the user to create and share their own maps, was used to place markers to locations on the map where trees had been identified and assessed. This enabled the researchers to keep track of which trees had already been completed. Each tree was named and numbered using the initials of the street name where it was found. For example, AS1 = Anglesea Street 1.

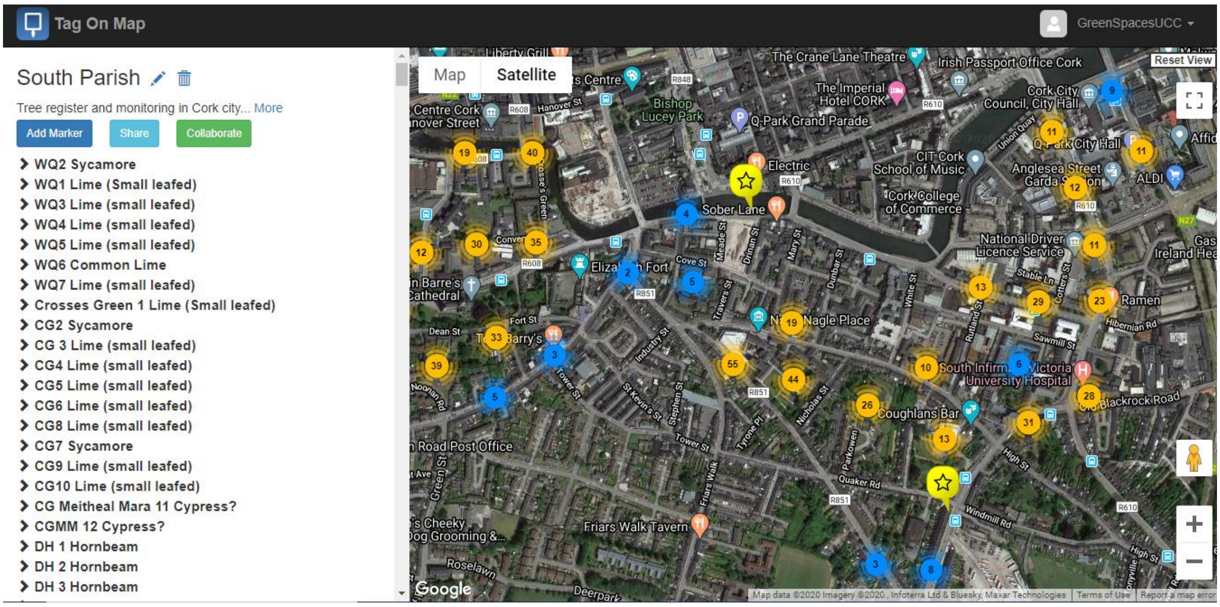

Figure 2.2: A screenshot of South Parish with tagged trees on TagOnMap.

The species of each tree was identified using Collins Tree Guide (Johnson and More, 2006) to help when needed. The circumference and diameter of the tree trunk were measured at breast height using a diameter tape. Two people were needed to get an approximate value for the height of each tree using the pencil/stick method. One person stood next to the tree with their feet as close as possible and in line with the base of the tree while the other stood as far back as possible so that the whole tree was visible. This person held a pencil up at arm's length, keeping the top of the pencil in line with the other person's head and closed one eye.

The point on the pencil where the other person's feet were (i.e. the base of the tree) was marked with a finger and then the number of these pencil lengths (from the top of the pencil/head to the marked point/feet) was counted up to the top of the tree. The number of pencil lengths was then multiplied by the height of the person standing next to the tree. For example, if there were 5 counts of the person and this person was 1.63 m tall, the height of the tree was approximately 8.15 m tall.

A score of the overall health was also given to each tree, ranging from 1-5 (1 being least healthy, 5 being most healthy). This was based on a visual appraisal of tree health. The information collected on each tree was inputted on TagOnMap before moving on to the next one. The data was later entered into an excel spreadsheet. A photo was taken of each tree for later reference.

The total number of trees surveyed was 1109 (Table 2.1).

Table 2.1: The total number of trees identified and surveyed in the South Parish, Cork, and the percentages of those trees valued using Helliwell and i-Trees Eco.

	Number	Percentage of Total
Trees Valued using Helliwell	320	29%
Trees Valued using i-Trees	1000	90%
Total Trees Surveyed	1109	

2.3 Visual Amenity Valuation – The Helliwell System

29% of the trees identified in the South Parish were valued using the Helliwell System (Helliwell, 2008). These trees were chosen to be a representative sample of the entire community of trees present in the area. Six factors were identified for each tree – size, duration, importance, tree cover, suitability to setting and form (Table 2.2). Each tree was given a score for each factor and then the score for the six factors were multiplied together. The product of the scores was then multiplied by the monetary conversion factor to get the visual amenity value of the tree in monetary terms. The current Helliwell point value (as of 2019) for individual trees is £33.70 (Trees.org.uk, 2019), which was converted to Euro using an online currency converter, - €39.33.

Factor	**Points**									
	0	0.5	1	2	3	4	5	6	7	8
i. Size	<2m²	2-5m²	5-10m²	10-20m²	20-30m²	30-50m²	50-100m²	100-150m²	150-200m²	>200m²
ii. Duration	<2		2-5	5-40	40-100	>100				
iii.Import-ance	None	Very little	Little	Some	Consider-able	Great				
iv. Tree cover		>70%	>30%	>10%	none					
v. Suitability to setting	Not	Poor	Just	Very	Particularl y					
vi. Form		Poor	Avera ge	Good						

Table 2.2: Visual amenity valuation table (Helliwell, 2008).

The size of the tree was calculated by multiplying the height of the tree (obtained during fieldwork) by the average crown diameter. The crown diameter was not calculated during the fieldwork so had to be estimated using a combination of google maps and photographs. The score for this factor ranged from 0-8, 0 being trees less than 2 m² in size and trees given a score of 8 being greater than 200 m² in size, as shown in Table 2. However, for trees less than 2 m², giving a score of 0 would mean that even if it got higher scores for all the other factors, it would still end up with an overall score of 0. This implies that a tree this small provides no visual amenity, which we considered misleading. It was determined that any trees this small would be given a score of 0.5 instead to combat this issue.

The duration factor refers to the estimated duration of time that the tree is likely to continue contributing to the visual amenity of its area. This factor involved first calculating the approximate age of the tree. This was done using an online calculator (Tree-guide.com, 2020). Research was then carried out to determine the typical biological life expectancy of each species, taking into account the fact that trees in an urban area are unlikely to live as long as trees located in countryside natural or semi-natural environment. The overall health of the tree was also incorporated into this factor. A tree that appears to be unhealthy will not score as highly here. The score range for this factor was 0 (less than 2 years remaining) to 4 (more than 100 years).

The importance factor relates to the visual prominence of the tree. Trees that are not seen by anybody or very few people due to being in a remote area generate a low score under this factor (e.g. Figure 2.3) while prominent trees in busy areas will score higher (e.g. Figure 2.4). This factor is therefore a combination of its prominence in the landscape and the size of the viewing population. Scores range from 0 (no importance) to 4 (great importance).

Tree cover was approximated by using satellite imagery on google maps. This factor refers to the general abundance of trees within the area. In areas where there are lots of trees, a tree will score lowly on this factor because its loss wouldn’t matter much. Conversely, if a tree is the only tree in the area, its loss would be more noticeable and would therefore score higher here. The scores range from 0.5 (woodland) to 4 (no other trees present). However, a score of 0.5 does not apply to any of the trees in this study because it is an urban area.

Figure 2.3 (left) and Figure 2.4 (right). The tree at St. Marie's of the Isle (Figure3) has a lower importance score than the tree at Anglesea Street (Figure 4) due to a relatively lower likelihood of it being viewed by the public.

Relation to setting involves determining the suitability of a tree to its setting, or how 'good' it looks there. Some trees may be too large for the location and may block out too much light from the buildings while other trees may appear too small in a large area and therefore look insignificant. Trees such as weeping willows would be considered very suitable when located next to flowing water and score highly. Also, trees that screen unpleasant views will score highly. This factor was very hard to determine. There were no trees that seemed totally unsuitable nor were there any trees that seemed particularly suitable. Most trees were therefore given a score of 2, meaning it is 'fairly suitable'.

The final factor considered was the form of the tree. For this, a combination of reverting back to the overall health scores and examining the photographs taken during the fieldwork were used. Form here was assessed in aesthetic terms. Most trees were rated average (1).

2.4 Carbon Sequestration and Storage using i-Tree Eco

The i-Tree Eco model (www.itreetools.org, 2020) is a software application developed by the United States Department of Agriculture Forest Service to quantify and assess urban forest structure and ecosystem services and disservices. The i-Tree suite of models is a popular tool used in cities across the United States for calculating monetary values for ecosystem services and benefits of trees (Nyelele *et al.,* 2019; Strunk *et al.,* 2016; King *et al.,* 2014). However, it has been adapted for use throughout many countries worldwide and has been used by several cities such as Barcelona, Spain (Baró *et al.,* 2014), Shenzhen City, China (Wu *et al*., 2019), Strasbourg, France (Selmi *et al*., 2016) and multiple urban areas across Great Britain (Raum *et al*., 2019). The software is free to download and is user-friendly. It requires basic field data to estimate the benefits provided by the trees being studied and additional information to improve the results received is optional.

The project was created on i-Tree Eco (version 6) and the "Complete Inventory" option was selected. The location was entered as "Cork, South-West, Ireland" and the nearest weather station (Cork Airport) was selected. This information was mandatory. To quantify benefits, the i-Tree Eco model requires at minimum the species of tree and the diameter at breast height. Other fields of information are optional but are highly recommended. The only other information selected for this study was the total tree height.

Before importing the field data from excel, it had to be adjusted slightly for i-Trees to accept it. The i-Tree Eco v6 Species List was downloaded from the i-Trees website (www.itreetools.org, 2020). The common name of each species was adjusted in excel to match this list. For example, "Apple Tree" had to be changed to "apple spp" for the software to recognise it. Once every tree name had been fixed accordingly, the data (including species name, diameter at breast height and total height) was imported into i-Trees. 1000 trees (90%) across the South Parish were analysed. A number of reports were generated by the i-Trees Eco model including a report containing carbon storage and sequestration.

2.5 Insect Biodiversity Measurement

This experiment involved the deployment of 10 yellow sticky traps. Each trap was numbered from 1-10 and 'Please do not touch' was written on them with permanent marker. String was attached to each sticky trap by a small hole on top of each.

Traps were divided in to two groups of five. Five were hung up on trees and the other five were hung on inanimate objects like poles and fences (Figure 2.5). The traps were divided evenly across Saint Finbarrs Cathedral, University College Cork Campus, and Food Forest.

Traps were left hanging up for one week. The weather forecast was checked before this experiment proceeded. Cold temperatures would have a negative effect on the project as most insects do not survive in cold weather. A picture was taken of each sticky trap when they were put up and when they were collected.

On collection each trap was put into a large plastic tub for protection. A layer of parchment paper divided each trap to preserve them. Each trap was then inspected individually. The number of insects were recorded.

Figure 2.5: Sticky Trap hanging from (left) American Chestnut (*Castanea dentata*) in Saint Finbarrs Cathedral, Cork and (right) from a metal pole in Saint Finbarrs Cathedral.

2.5 Online Surveys of Opinion

Two surveys were carried out as part of the South Parish Tree Audit project. Surveys were created and circulated using Google Forms or Survey Monkey. The surveys were shared via School of BEES social media, LinkedIn, Instagram, Twitter, Snapchat, and WhatsApp. Each survey was tested on a small group of individuals to ensure the questions were easily understood.

2.6 Data Analysis

All data recorded were inputted into Microsoft Excel and a number of appropriate graphs were produced. Two scatterplots were created to show the relationship between Visual Amenity Value and Height, and between Visual Amenity Value and Age. Correlation analysis was performed for both graphs by generating the Pearson product-moment correlation coefficient, *r*, and then comparing this with the corresponding table of critical values to determine significance. Regression analysis was also carried out by generating trendline equations with Excel. Other bar charts produced using Excel were; Mean Visual Amenity Value vs Species, Total Visual Amenity Value vs Location and Mean Visual Amenity Value vs Location. Bar charts were also produced for the mean carbon sequestration rate and mean carbon storage of each tree species. Statistical Analysis was performed with SPSS (IBM Statistics 26). Mean visual amenity values, mean carbon sequestration and mean carbon storage results were analysed using Kruskal-Wallis tests and pairwise comparisons through SPSS. Tables of P-values for pairwise comparisons were created (not presented).

3. Results

3.1. Species Assemblage

Lime trees (*Tilia* spp., Figure 3.1) were the most common trees seen across the South Parish (Table 3.1), accounting for 21.3% of all the trees in the area. The next most common tree, Sycamore (*Acer* spp.), account for less than half of the number of lime trees (8.9%). Hornbeam (*Carpinus* spp.; 7.8%) and Holly (*Ilex aquifolium*; 4.4%) were also common (Figure 3.2). For a number of species, only one individual tree was observed, including: Larch (*Larix* spp.), Maple (*Acer* spp.), Turkey Oak (*Quercus cerris*), Atlas cedar (*Cedrus atlantica*) and Arbutus (*Arbutus unedo*)

In total, 1109 trees were surveyed as part of this study. This accounts for all safely accessible trees in the South Parish area. Of those surveyed, a number were shown to be dead, and a small number could not be positively identified. Data relating to 1000 trees were further analysed using iTrees. These trees represented identified, living trees for which data had been collected that could be processed using the iTrees system.

Figure 3.1: Screenshot taken on Google Maps of a large Lime tree on Anglesea Street.

Table 3.1: The total number of trees of each type found across the South Parish *and* analysed using iTrees, showing the percentage total of each tree type. (continued overleaf)

Species	Number of Trees	Percent of Population
Common lime	213	21.3%
Sycamore maple	89	8.9%
European hornbeam	78	7.8%
holly spp	44	4.4%
birch spp	40	4.0%
apple spp	32	3.2%
European white birch	29	2.9%
maple spp	26	2.6%
Cherry plum	24	2.4%
Littleleaf linden	21	2.1%
hoheria spp	20	2.0%
Bay laurel	20	2.0%
ash spp	20	2.0%
Giant dracaena	18	1.8%
bay tree spp	16	1.6%
hawthorn spp	13	1.3%
sumac spp	13	1.3%
Japanese maple	12	1.2%
Italian alder	11	1.1%
magnolia spp	11	1.1%
European mountain ash	11	1.1%
plum spp	10	1.0%
beech spp	10	1.0%
Tawhiwhi	10	1.0%
European beech	9	<0.1%
serviceberry spp	8	<0.1%
Arbol de judea	8	<0.1%
Persian silk tree	8	<0.1%
cypress spp	7	<0.1%
Myrtle	7	<0.1%
London planetree	7	<0.1%
elderberry spp	7	<0.1%
Service Tree	6	<0.1%
Horse chestnut	6	<0.1%
Copper beech	6	<0.1%
Ginkgo	6	<0.1%
Bigleaf linden	5	<0.1%
Whitebeam	5	<0.1%
willow spp	5	<0.1%
Downy birch	5	<0.1%
hazelnut spp	5	<0.1%
bamboo spp	4	<0.1%
European silver birch	4	<0.1%
Leyland cypress	4	<0.1%
yew spp	4	<0.1%
Windmill palm	4	<0.1%
Hinoki cypress	3	<0.1%
Weeping european larch	3	<0.1%
olearia spp	3	<0.1%
oak spp	3	<0.1%

Durmast oak	3	<0.1%
Port orford cedar	3	<0.1%
Black cherry	2	<0.1%
English yew	2	<0.1%
Shumard oak	2	<0.1%
pear spp	2	<0.1%
Cherry laurel	2	<0.1%
London plane	2	<0.1%
Japanese pieris	2	<0.1%
Tulip tree	2	<0.1%
Japanese red cedar	2	<0.1%
Scarlet hawthorn	2	<0.1%
cordyline spp	2	<0.1%
Sweet chestnut	2	<0.1%
Indian paper birch	2	<0.1%
River birch	2	<0.1%
Common ash	2	<0.1%
English oak	2	<0.1%
alder spp	2	<0.1%
Turkey oak	1	<0.1%
larch spp	1	<0.1%
European larch	1	<0.1%
sweetgum spp	1	<0.1%
European medlar	1	<0.1%
Norway spruce	1	<0.1%
Blue spruce	1	<0.1%
Mountain pine	1	<0.1%
Evergreen oak	1	<0.1%
Goat willow	1	<0.1%
English walnut	1	<0.1%
Water birch	1	<0.1%
Purpleleaf plum	1	<0.1%
Black walnut	1	<0.1%
Witch hazel	1	<0.1%
European ash	1	<0.1%
Flowering dogwood	1	<0.1%
cotoneaster spp	1	<0.1%
dogwood spp	1	<0.1%
Atlas cedar	1	<0.1%
hackberry spp	1	<0.1%
katsura tree spp	1	<0.1%
Weeping birch	1	<0.1%
Large gray willow	1	<0.1%
Strawberry tree	1	<0.1%
Red maple	1	<0.1%
hornbeam spp	1	<0.1%
Total	**1,000**	**100%**

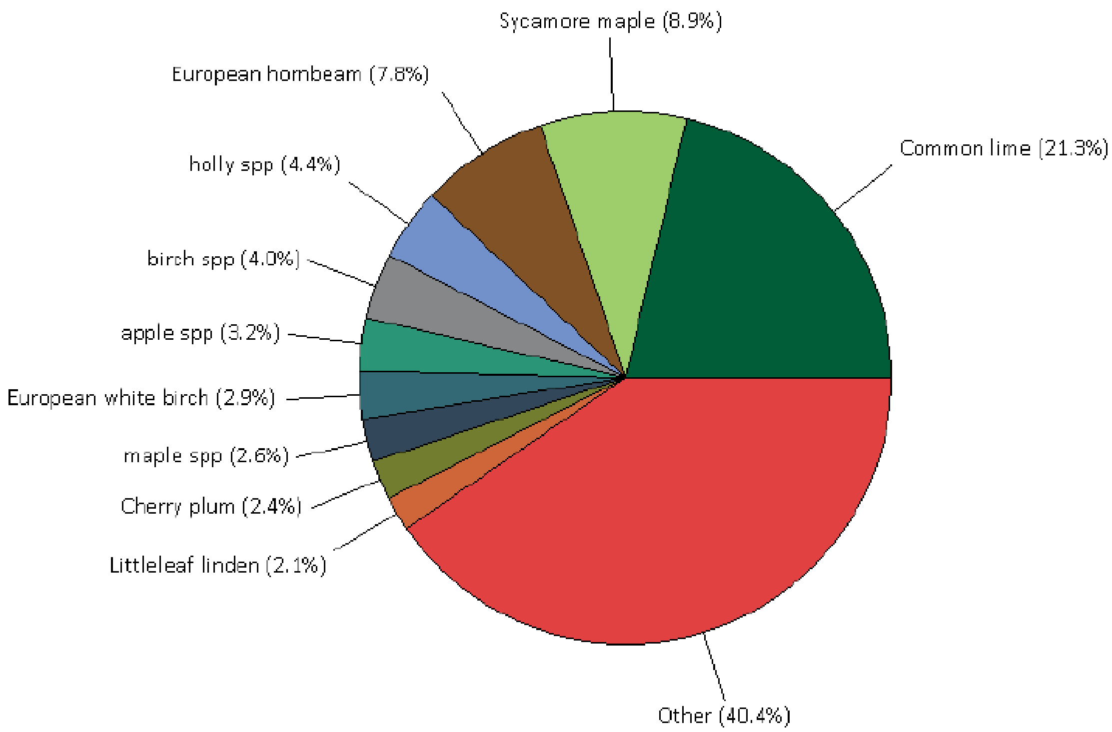

Figure 3.2: Percentage of the South Parish tree community made up of common tree types.

3.2. Helliwell Analysis

The total visual amenity value for 320 trees located in the South Parish area of Cork City was calculated to be €712,224. Based on a total number of trees surveyed of 1109, this suggests the total visual amenity value of the entire tree population of the South Parish could be as much as €2,500,000.

3.2.1 Height vs Visual Amenity Value

There was a positive correlation between height and visual amenity value of the trees (Figure 3.3). The R^2 value is 0.4099, meaning R is = 0.64. For N>300, the Pearson product-moment correlation coefficient yielded a p-value of <0.01, meaning there is a highly significant relationship between tree height and visual amenity value.

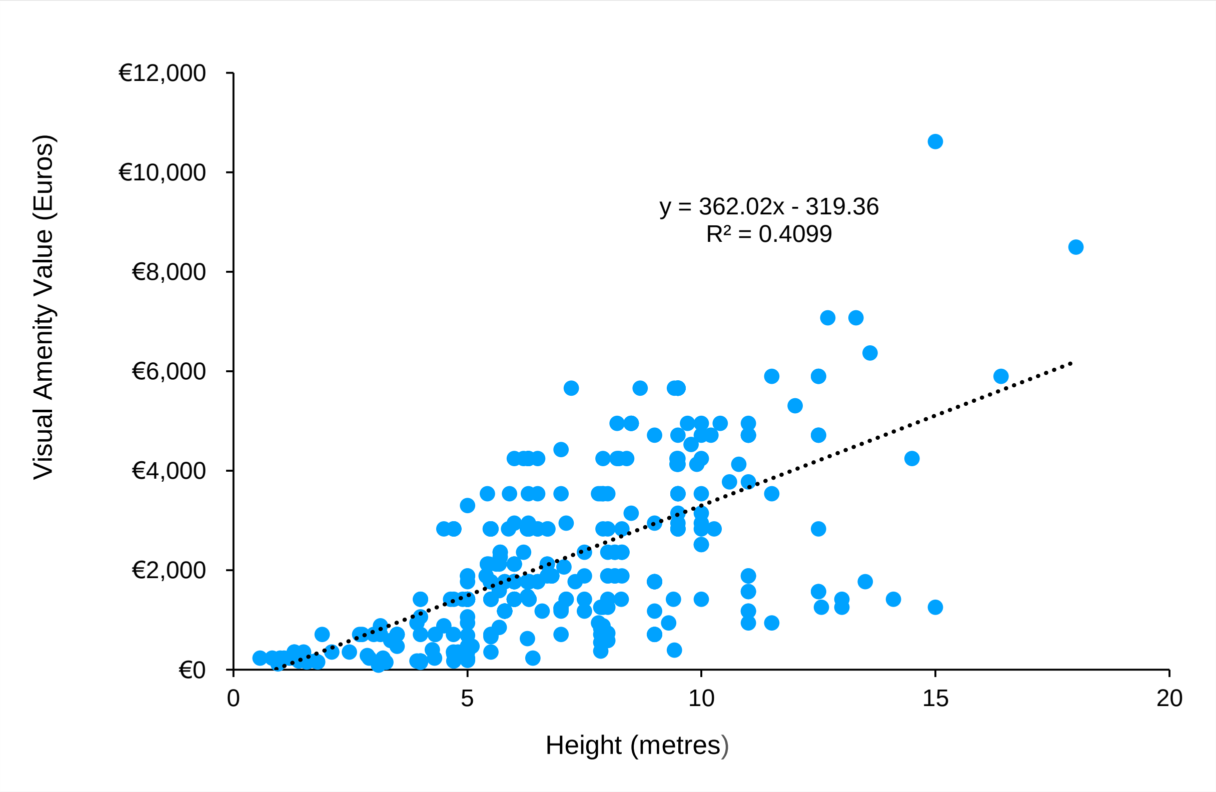

Figure 3.3: Scatterplot showing the positive correlation between height and visual amenity value of trees in the South Parish.

3.2.2 Age vs Visual Amenity Value

There is a positive correlation between tree age and visual amenity value of the trees (Figure 3.4). The R^2 value is 0.195, meaning R= 0.44. For N>200, the Pearson product-moment correlation coefficient table gives a p-value of <0.01, meaning there is a highly significant relationship between tree age and visual amenity value.

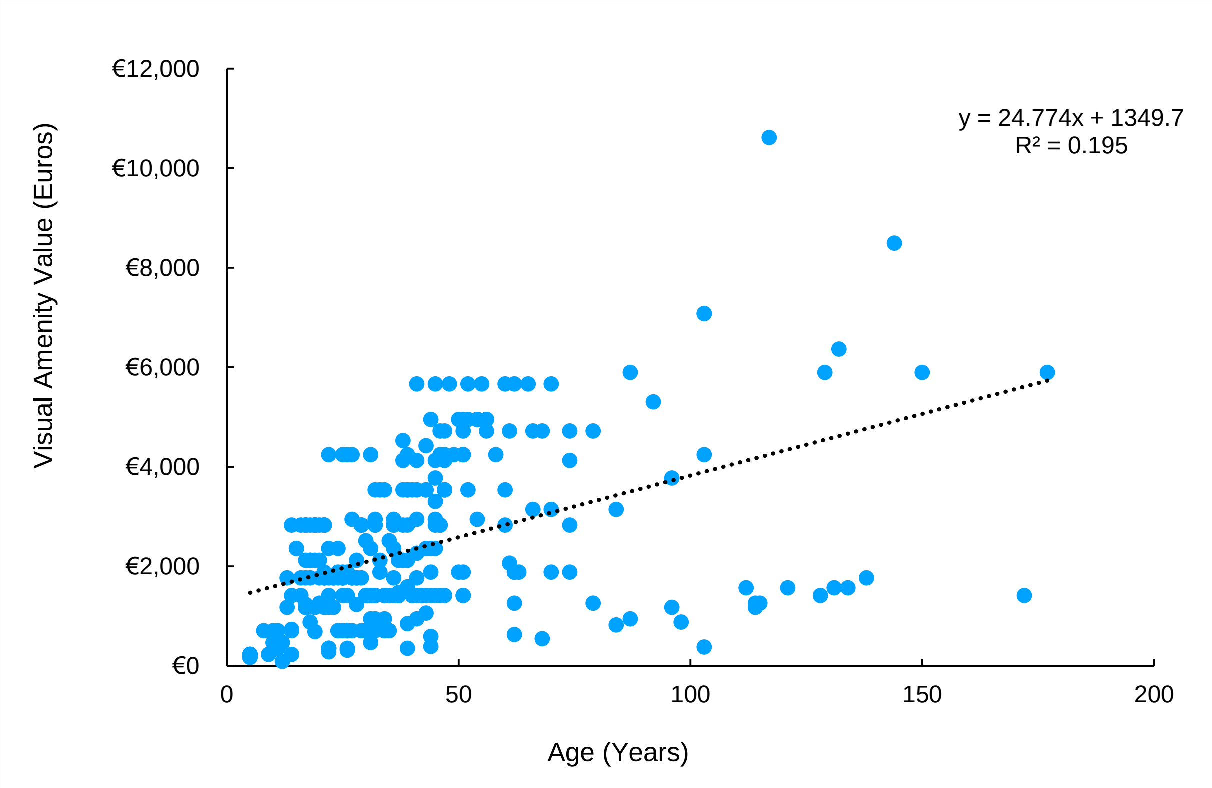

Figure 3.4: Scatterplot showing the positive correlation between age and visual amenity value of trees in the South Parish.

3.2.3 Mean Visual Amenity Value for each Tree Type

Figure 3.5 shows that Lime trees have the highest mean visual amenity value (average of €3655 per Lime tree) while Hazel (*Corylus* spp.), Larch, Cabbage Palm (*Sabal* spp.) and Myrtle trees (*Myrtus* spp.) all had mean visual amenity values of less than €200 per tree. A Kruskal-Wallis Test showed that there is a significant difference in mean visual amenity values across the different tree types (p-value of 0.000). Pairwise comparisons showed that Lime trees are the most different, there were only five tree types that showed no statistically significant difference to Lime trees (Table 3.2).

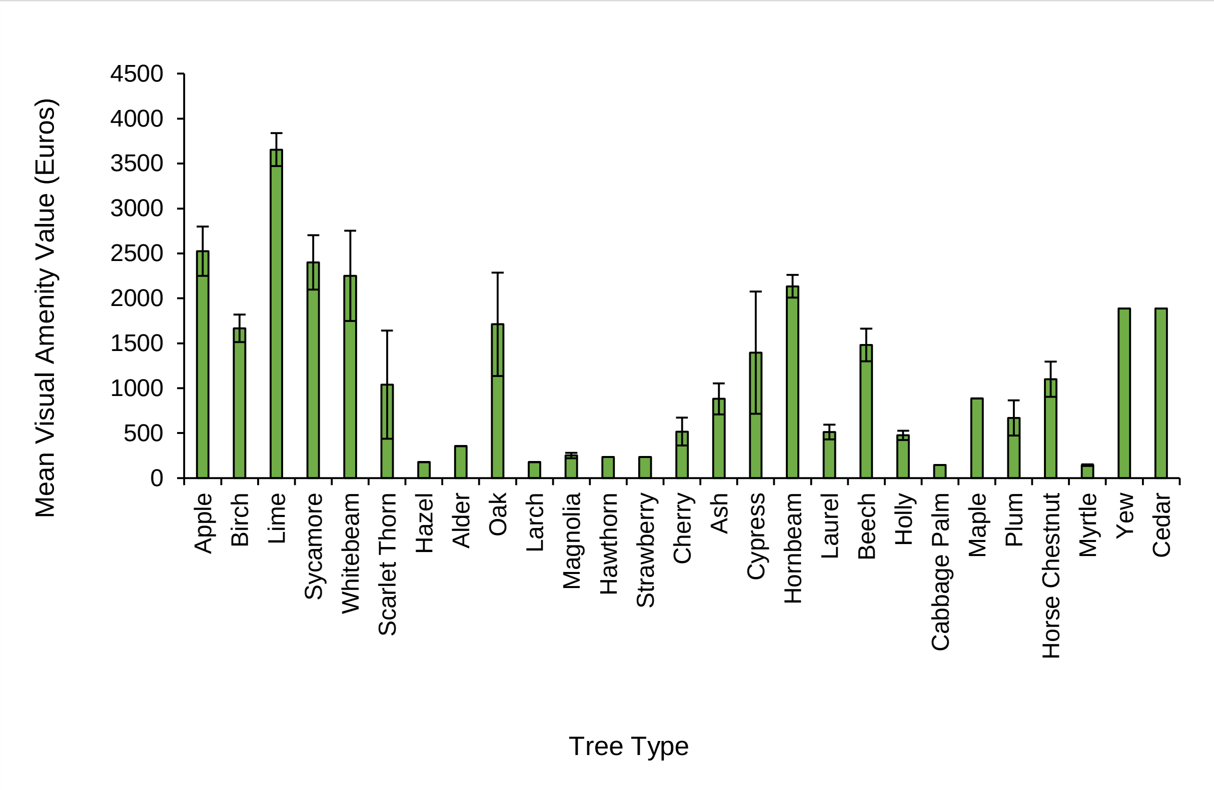

Figure 3.5: Bar chart showing the mean visual amenity value (+/- 1 S.E.) of each tree type found in the South Parish.

Tree Type	Cabbage Palm	Myrtle	Larch	Hazel	Magnolia	Hawthorn	Strawberry	Alder	Holly	Laurel	Cherry	Plum	Ash	Maple	Cypress	Horse Chestnut	Scarlet Thorn	Beech	Oak	Birch	Hornbeam	Sycamore	Whitebeam	Cedar	Yew	Apple	Lime
Cabbage Palm		0.994	0.957	0.951	0.857	0.862	0.887	0.809	0.677	0.708	0.652	0.613	0.488	0.578	0.400	0.410	0.415	0.207	0.199	0.149	0.078	0.073	0.090	0.126	0.185	0.043	0.012
Myrtle			0.954	0.942	0.788	0.814	0.868	0.773	0.507	0.622	0.493	0.504	0.304	0.500	0.192	0.248	0.278	0.060	0.062	0.016	0.003	0.003	0.011	0.041	0.106	0.001	0.000
Larch				1.000	0.913	0.914	0.930	0.851	0.731	0.755	0.704	0.658	0.533	0.615	0.441	0.448	0.451	0.233	0.224	0.171	0.092	0.086	0.104	0.142	0.204	0.051	0.015
Hazel					0.884	0.891	0.919	0.828	0.638	0.702	0.612	0.587	0.414	0.561	0.301	0.337	0.356	0.118	0.116	0.056	0.018	0.017	0.033	0.072	0.142	0.008	0.001
Magnolia						0.989	0.993	0.887	0.588	0.735	0.574	0.589	0.319	0.574	0.160	0.261	0.307	0.037	0.042	0.001	0.000	0.000	0.003	0.033	0.113	0.000	0.000
Hawthorn							1.000	0.903	0.717	0.778	0.683	0.647	0.445	0.612	0.306	0.358	0.382	0.105	0.106	0.036	0.008	0.007	0.023	0.067	0.148	0.004	0.000
Strawberry								0.920	0.824	0.833	0.792	0.733	0.610	0.678	0.514	0.515	0.515	0.280	0.269	0.213	0.118	0.111	0.130	0.172	0.237	0.067	0.021
Alder									0.931	0.924	0.896	0.821	0.703	0.753	0.603	0.597	0.592	0.342	0.328	0.268	0.155	0.146	0.166	0.211	0.279	0.090	0.031
Holly										0.971	0.913	0.804	0.530	0.731	0.298	0.413	0.453	0.068	0.076	0.001	0.000	0.000	0.006	0.057	0.164	0.000	0.000
Laurel											0.976	0.873	0.720	0.789	0.583	0.589	0.589	0.269	0.259	0.167	0.066	0.062	0.094	0.157	0.248	0.032	0.004
Cherry												0.865	0.637	0.776	0.427	0.496	0.519	0.124	0.128	0.018	0.001	0.001	0.019	0.083	0.193	0.001	0.000
Plum													0.867	0.891	0.729	0.715	0.704	0.361	0.345	0.245	0.107	0.099	0.138	0.210	0.306	0.052	0.008
Ash														0.979	0.814	0.792	0.774	0.323	0.313	0.141	0.028	0.027	0.082	0.183	0.309	0.013	0.000
Maple															0.920	0.887	0.863	0.586	0.562	0.504	0.327	0.310	0.328	0.375	0.443	0.203	0.086
Cypress																0.931	0.893	0.390	0.375	0.147	0.018	0.019	0.090	0.215	0.355	0.010	0.000
Horse Chestnut																	0.959	0.555	0.526	0.394	0.162	0.151	0.214	0.313	0.425	0.076	0.008
Scarlet Thorn																		0.646	0.614	0.521	0.279	0.261	0.304	0.382	0.475	0.147	0.034
Beech																			0.937	0.863	0.397	0.365	0.452	0.558	0.655	0.178	0.014
Oak																				0.954	0.510	0.471	0.528	0.614	0.696	0.246	0.035
Birch																					0.146	0.154	0.414	0.577	0.689	0.070	0.000
Hornbeam																						0.837	0.855	0.891	0.922	0.303	0.000
Sycamore																							0.931	0.939	0.956	0.397	0.001
Whitebeam																								0.987	0.990	0.631	0.153
Cedar																									1.000	0.748	0.368
Yew																										0.813	0.522
Apple																											0.237
Lime																											

Table 3.2: Pairwise comparisons of 27 tree types valued using the Helliwell System. P-values in green are less than 0.05, so they are statistically

3.2.4 Total Visual Amenity Value Per Street/Location

South Terrace (as seen in Figure 3.7) had the highest total visual amenity value (Figure 3.6) for the locations that were valued using the Helliwell System, being worth a total of €172,398, accounting for approximately 24% of the total visual amenity value of all valued trees in the South Parish. This is more than double the next highest total, which is Anglesea Street (€73,916). Anglesea Place on Copley Street had the lowest total visual amenity value, at €4,277. Douglas Street (Figure 3.8) also had very few trees and therefore a low total visual amenity value.

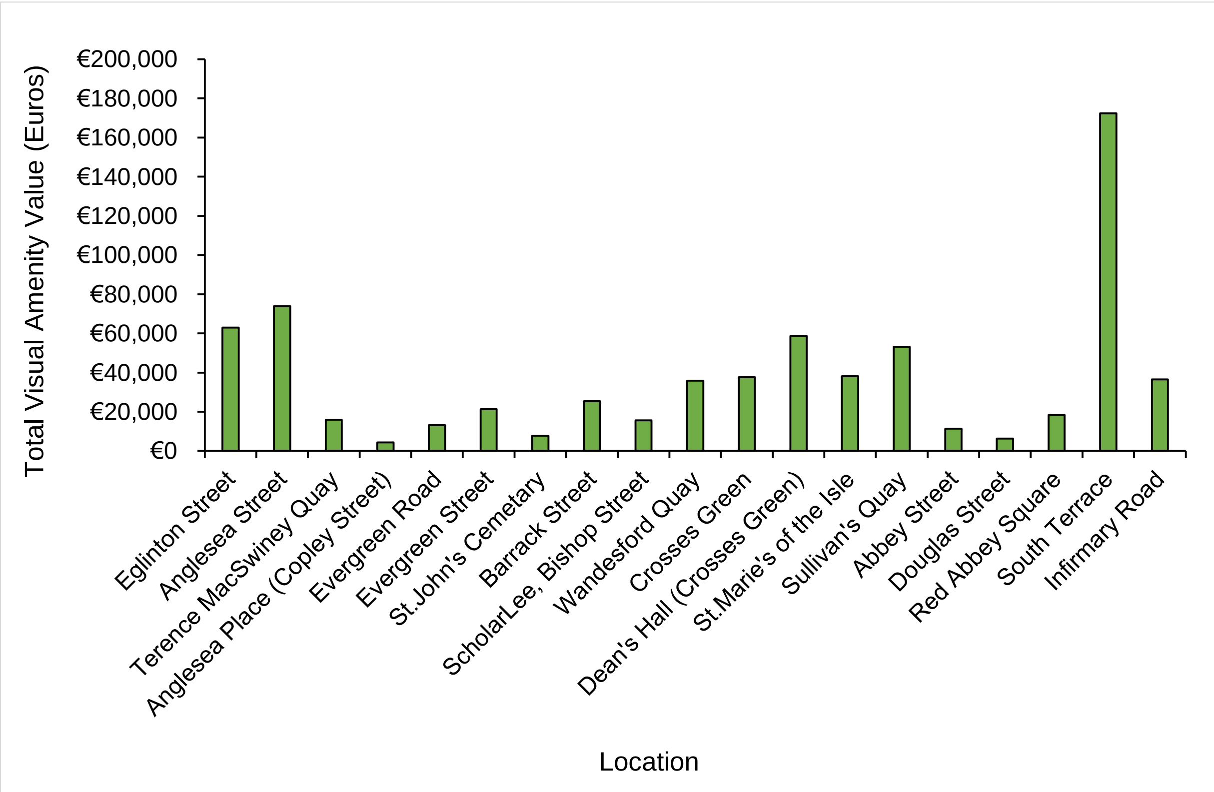

Figure 3.6: Total visual amenity value of trees in different locations across the South Parish.

Figure 3.7: Screenshot taken on Google Maps of South Terrace, showing Lime trees on the right of the photo and Hornbeam trees on the left. This was the most valuable street in the South Parish in terms of total visual amenity value of trees.

Figure 3.8: Screenshot taken on Google Maps of Douglas Street, a street with a low total visual amenity value, showing 1 of only 3 trees located here (a Birch tree).

3.2.5 Mean Value of Trees at Each Location

On average, the trees located on Sullivan's Quay (Figure 3.10) had the highest mean visual amenity value (Figure 3.9). The trees located in St. John's Cemetery (Figure 3.11) had the lowest mean visual amenity value.

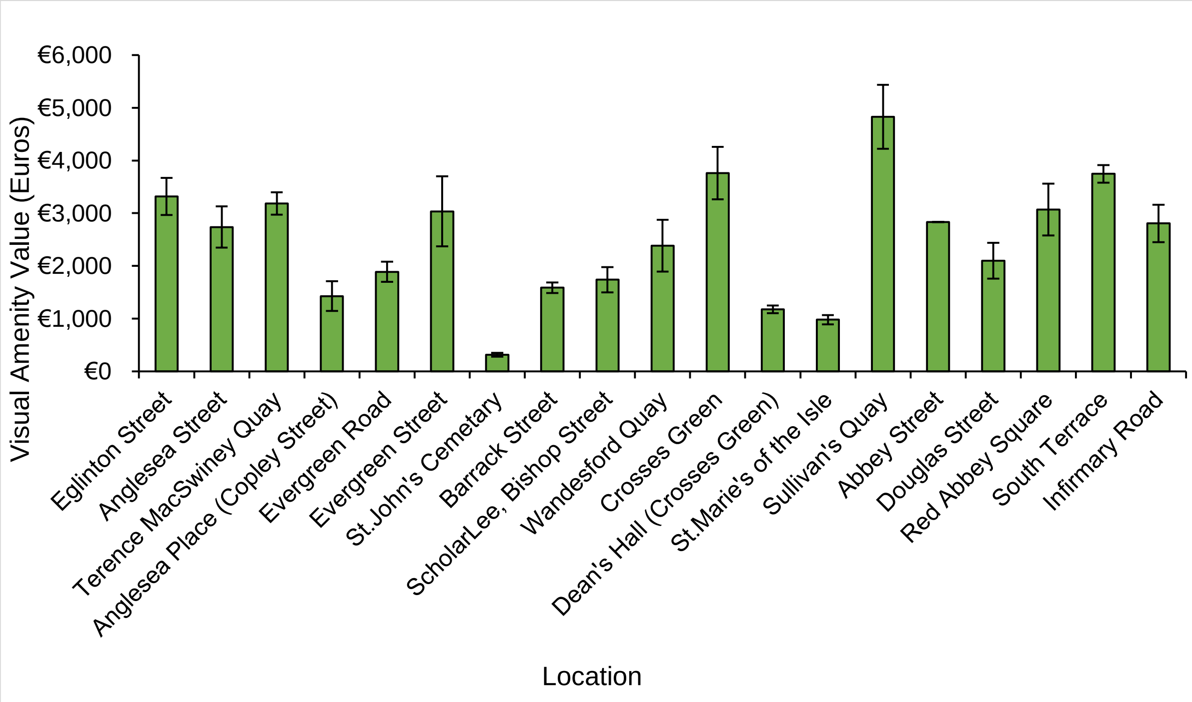

Figure 3.9: Mean (+/- 1 S.E.) visual amenity values of trees found in different locations across the South Parish.

Figure 3.10: Screenshot taken on Google Maps of Sullivan's Quay, showing a row of trees that had high mean visual amenity values.

Figure 3.11: A newly planted Larch tree in St. Johns Cemetery.

3.3 Insect biodiversity Survey

Figure 3.12: Sticky Trap number 6 at Saint Finbarrs Cathedral after one week. Lichens and insects attached.

One sticky trap hanging on a tree on University College Cork Campus was no longer there after a week. The highest number of insects were found on a roadside sticky trap in Saint Finbarrs Cathedral grounds, hanging on a fence. There were 16 insects found on this trap. The next highest was found on a tree in Saint Finbarrs Cathedral ground with 9 insects. The sticky trap with the least insects was found on a metal pole by the internal wall of Saint Finbarrs Cathedral. This sticky trap had 2 insects attached.

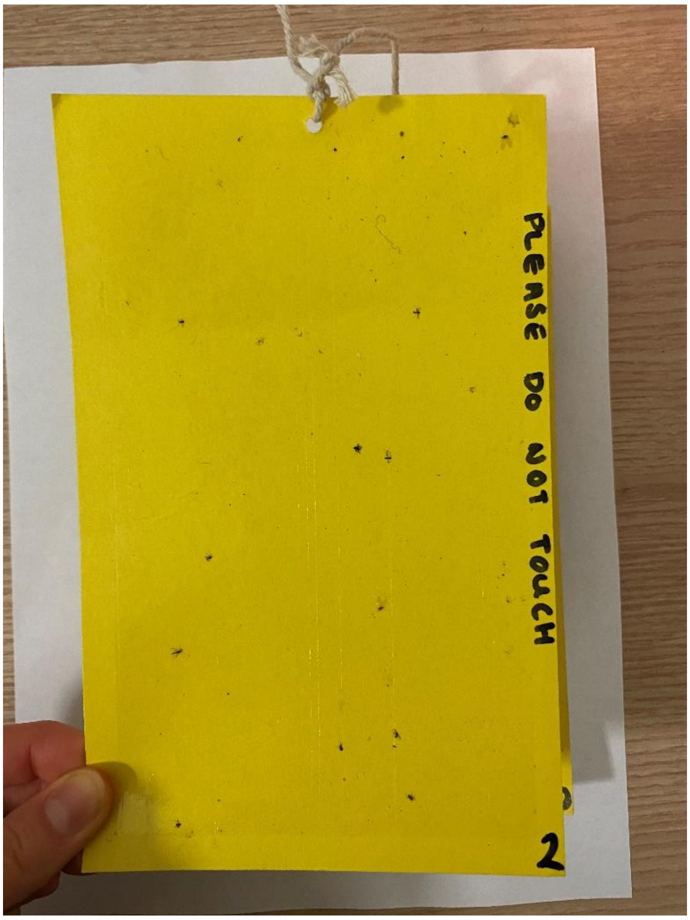

Figure 3.13: Sticky trap number 2 collected from Saint Finbarrs Cathedral with insects attached.

The Forest Food sticky traps were both beside a main road. The sticky trap on a tree collected 5 while the sticky trap on a telephone pole collected 7.

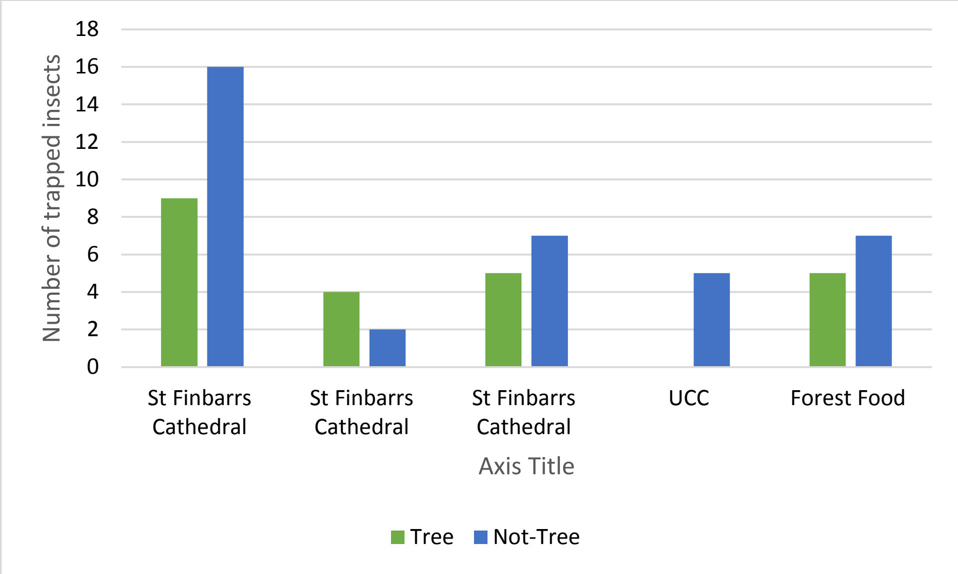

Figure 3.1: Number of Insects found on Sticky Traps

The total of 23 insects were found on sticky traps on trees. The total number of insects found on non-tree sticky traps was 32. A chi-squared analysis of the data collected indicated that there was no significant difference between the number of insects found at the 'tree' versus 'non-tree' sites. This is a relatively small-scale study carried out at the off-peak time for insect abundance and activity so more study is planned in this area with the recent recruitment of a postgraduate student to examine the relationship between urban trees and biodiversity in Cork city.

	Number of insects	Expected Value
Tree	23	27.5
Non-tree	32	27.5
Total	55	55
P-value	0.224915884	(NS)

Chi-square table

3.4 Carbon Sequestration and Storage

The gross carbon sequestration of 1000 trees in the South Parish is approximately 15.68 metric tonnes (15,680 kg) per year, with an associated value of €2519/year. This is equivalent to 57.5 metric tonnes CO^2 Equivalent per year ($MTCO^2e$/year). These trees are storing approximately 534 metric tonnes (534,000 kg) of carbon, which is valued at €85,871.

The top 5 tree types for sequestering carbon in the audit (based on mean carbon sequestration rates per tree, see Figure 3.15) are:

1. Water birch (*Betula occidentalis*) 40 kg/tree/year
2. Common ash (Fraxinus excelsior) 40 kg/tree/year
3. London plane (*Platanus × hispanica*) 40 kg/tree/year
4. Common Lime (*Tilia x europaea*) 33.2 kg/tree/year
5. Beech (*Fagus* spp.) 33 kg/tree/year

The largest amount of carbon sequestered by a single tree was by a Common Lime sequestering an estimated 121.5 kg of carbon per year.

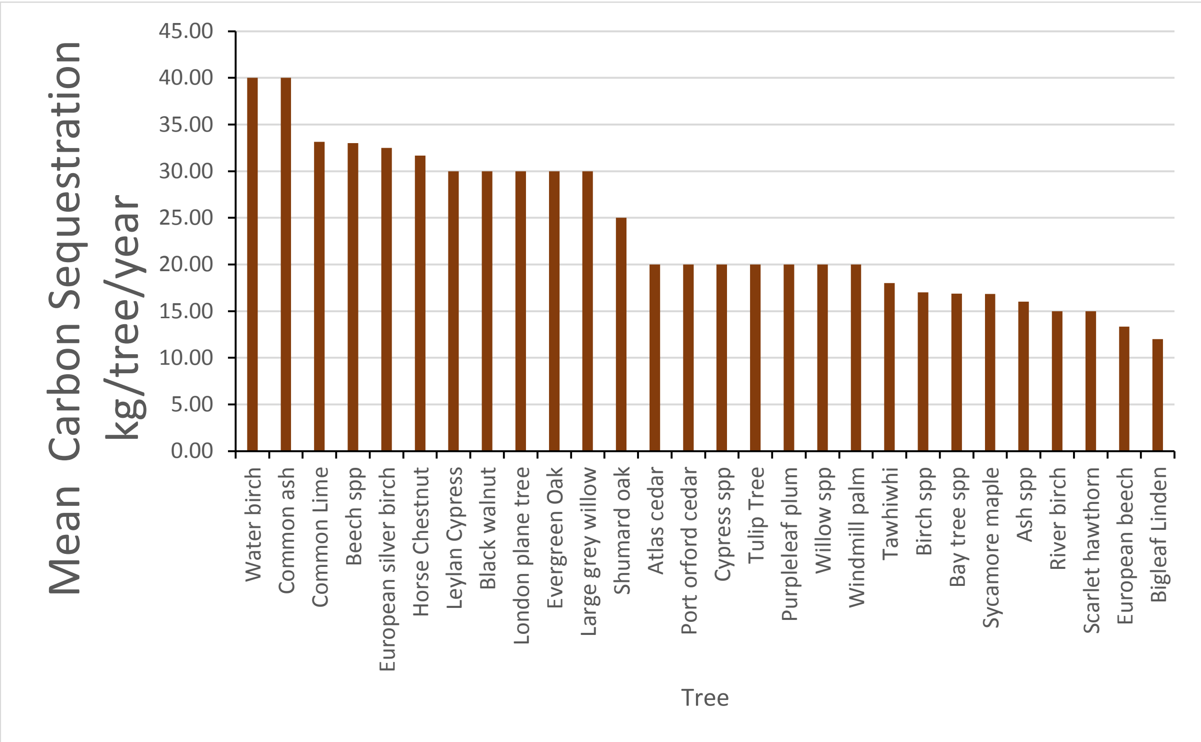

Figure 3.15: Mean carbon sequestration (kg/tree/year) of different tree types in the South Parish. These trees represent the top 28 trees in terms of mean annual carbon sequestration as estimated using the iTrees method.

The top 5 tree types for *storing* carbon in the audit (based on mean carbon stored per tree, see Figure 3.16) are:

1. Evergreen Oak (Quercus spp.) 4650 kg
2. Beech spp. (*Fagus* spp.) 3207 kg
3. English Yew (*Taxus baccata*) 2760 kg
4. London Plane (*Platanus × hispanica*) 2227 kg
5. Whitebeam (*Sorbus* spp.) 1998 kg

43% of all carbon stored in the trees of the South Parish are stored in Common Lime (*Tilia x europaea*) trees. As these are not amongst the top performers in terms of mean carbon stored per tree, this is a reflection of (a) the frequency at which they are planted throughout the survey area and (b) the relative maturity of that species population. In total, it is estimated that Common Lime stores 229 metric tonnes (229,000 kg). This is equivalent to 841 metric tonnes CO^2 Equivalent ($MTCO^2e$).

The estimated total carbon stored in all of the South Parish trees is 534 metric tonnes (534,000 kg). This is equivalent to 1960 metric tonnes CO^2 Equivalent ($MTCO^2e$).

The highest carbon stored by a single tree was 35,885 kg, stored in a Beech tree.

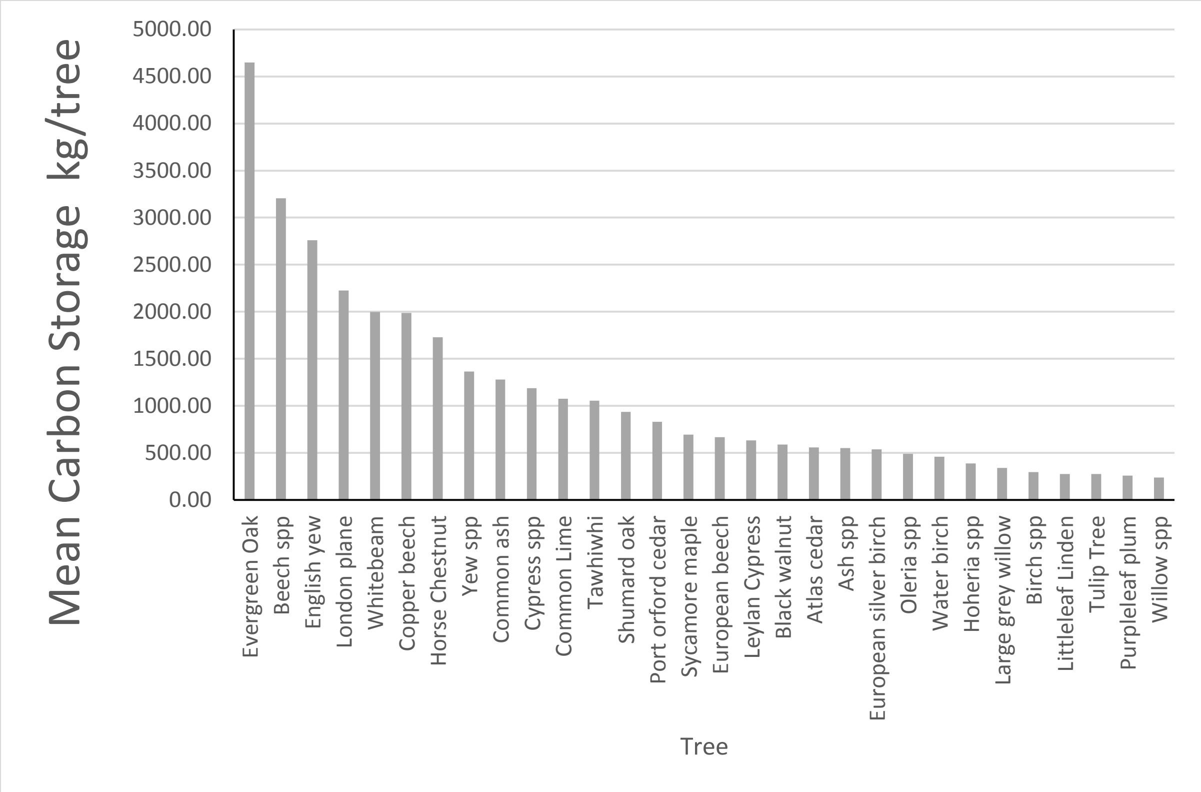

Figure 3.16: Mean carbon storage (kg) of different tree types in the South Parish. These trees represent the top 30 trees in terms of mean annual carbon storage per tree as estimated using the iTrees method.

3.5 Online Surveys of Opinion

300 responses were received from this survey. 55% of all respondents currently live in Cork City. The largest age group at 33.9% was 19-29 years.

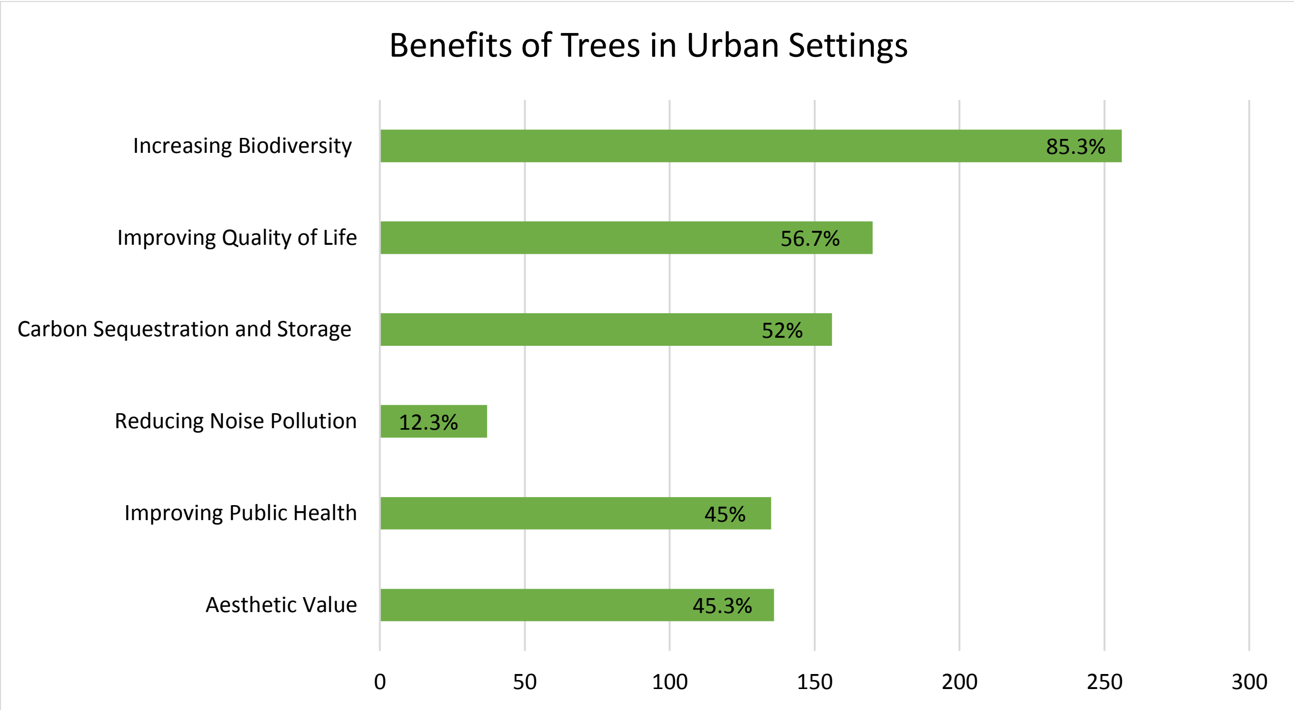

Figure 3.17: 'In your opinion, what are the most important benefits of trees in urban settings?'

85.3% of people selected ‘increasing biodiversity’ as their most important benefit of trees in urban settings (Figure 3.17). The next highest is improving quality of life at 56.7%. The lowest selected option was ‘reducing noise pollution’ at 12.3%.

When asked about how spending time in the presence of trees and other biodiversity impacts your mood, the vast majority of respondents said it had a huge positive impact. 80.3% of respondents agreed that it had a huge impact. Only 0.7% of people said that it had no impact at all on their mood.

77.3% of people agree that more trees are needed in Cork City.

202 people out of 300 (67%) thought that planting trees in urban settings was extremely important for combating climate change. Just 2.7% of respondents thought that it was not important at all.

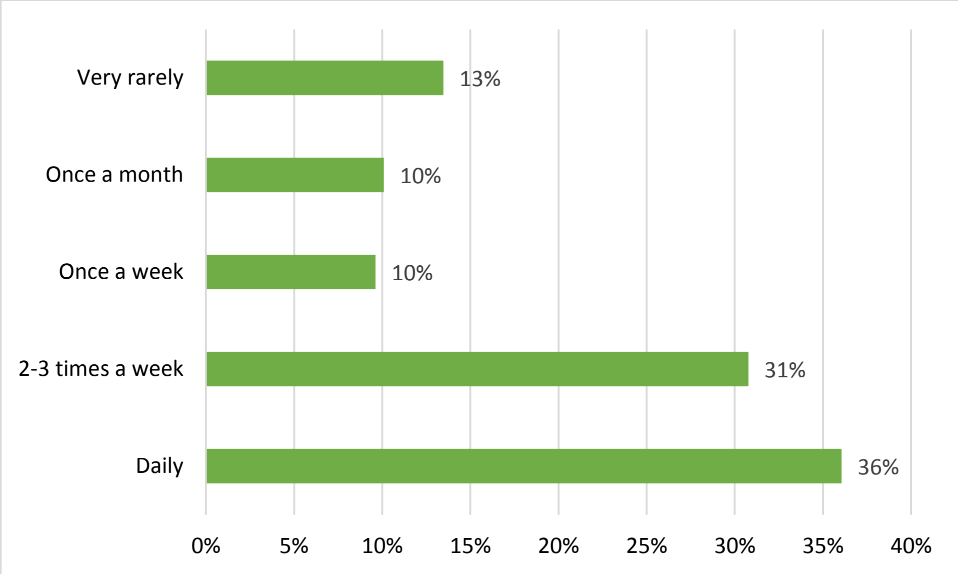

Figure 3.18:. 'How often do you use the green spaces of Cork City?'.

36% of people living in Cork City said that they use the green spaces of Cork daily. 31% said that they use them 2 to 3 times a week (Figure 3.18).

More than half of people surveyed said that they spend much more time visiting the urban green spaces of Cork since the beginning of the pandemic in March. 11% said that they use urban green spaces a lot less.

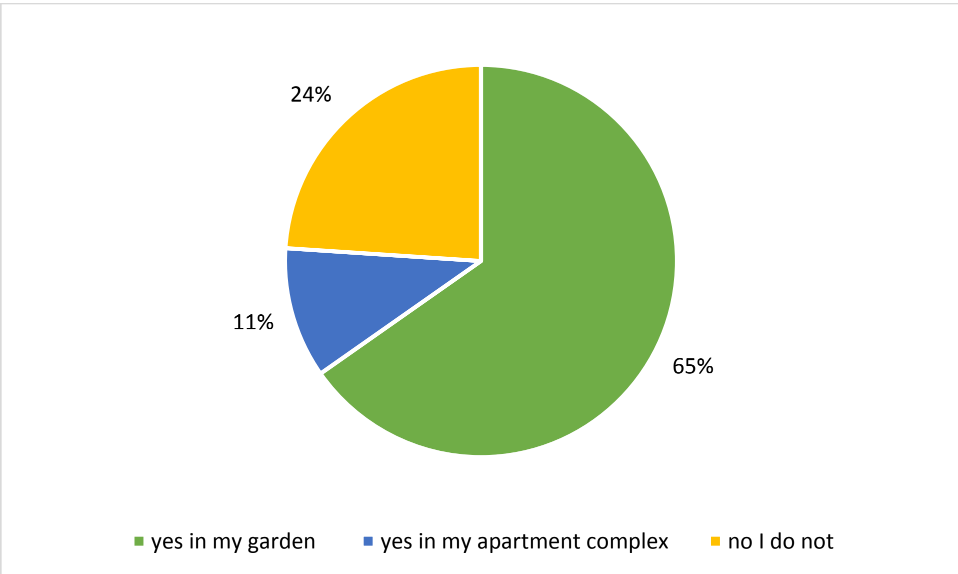

Figure 3.19:. 'If you are a resident of Cork City, do you have trees in your living area?'.

65% of people living in Cork City have trees in their living area (Figure 3.19). This particular analysis excludes people that completed the survey but do not live in Cork City. 11% of people have trees in their apartment complex, while 24% do not have trees in their living area.

88% of people surveyed felt that they were averagely informed or above on the importance of biodiversity and other benefits of trees in urban settings. Only 12% felt that their knowledge was below average.

In a separate survey of opinion, carried out under the auspices of the South Parish Tree Audit project, participants were questioned on the perceived disadvantages of urban trees. The biggest disadvantage of urban trees according to respondents overall was “Tree root damage to footpaths, roads and buildings” (Figure 3.20). 36% of respondents voted for this as the number 1 disadvantage. Respondents were least concerned about the disadvantage “Too large and require regular pruning” with only 4% of respondents choosing this as the biggest disadvantage.

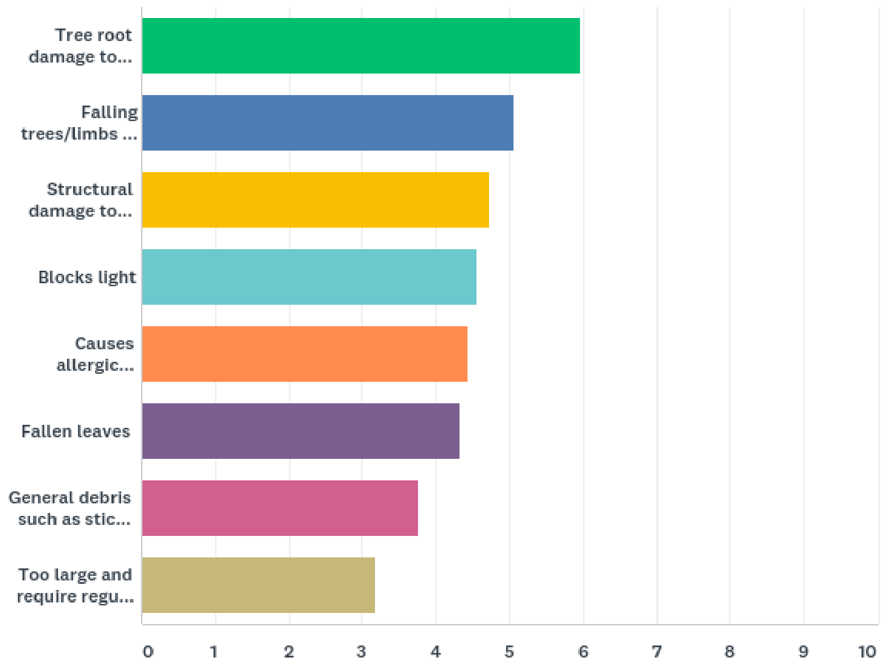

Figure 3.20: Graph generated by Survey Monkey, showing the weighted average scores of the disadvantages of urban trees, from greatest disadvantage to smallest disadvantage, as perceived by respondents.

When examining age demographics, all age groups except the youngest (18-24 years) and oldest (65+) saw tree root damage as the greatest disadvantage. For the 18-24 age group, this disadvantage was a very close second, with "Falling trees/limbs of trees a danger to society" achieving the top spot. In the 65+ age category (of which there were only 5 respondents), tree root damage was actually considered to be the least disadvantageous. "Blocks light" was considered the biggest disadvantage in this group.

91% of respondents strongly agreed that the benefits of urban trees outweigh the disadvantages and 7% agreed with this statement. 2 people neither agreed nor disagreed, 1 person disagreed and one person strongly disagreed.

4. Discussion

Trees can bring life and colour into otherwise bleak and dull urban areas. Trees deliver a variety of benefits including aesthetic, ecological, economic and social effects. Studies have shown that where trees are planted, they significantly increase the visual quality of that area (Polat *et al.,* 2015). These perceived benefits were supported by the survey results outlined here, with "Aesthetic Value" being ranked the 4th most important benefit by respondents (Figure 3.17).

4.1 Visual Amenity Value

The visual contribution of trees across the South Parish area of Cork City was calculated. Of the 1109 trees surveyed, 320 of them were valued using the Helliwell System. The total visual amenity value for these trees was calculated to be €712,224. The real visual amenity value of trees in the South Parish is even higher than this because only c. 29% of the trees identified were valued using this method, due to resource restrictions.

However, the Helliwell System has flaws which may result in some trees being overvalued and others being undervalued. The Helliwell System also fails to take into account the species of tree being evaluated, which could be an important factor to consider in future studies, seeing as some tree species look more visually pleasing than others, but again this is subjective. Previous studies have shown that when comparing different methods of tree appraisal, the Helliwell System showed the highest variation between appraisers, values may differ as much as 491% (Watson, 2002; Ponce-Donoso *et al.,* 2017). Therefore, it is necessary to note that these values could vary considerably if carried out by somebody else.

4.1.1 Tree Height

As was expected, the visual amenity value of trees increased as the height of the tree increased (see Figure 3.3). Large-stature trees deliver bigger and better benefits than small-stature trees, including enhancing the attractiveness of an area (Geiger, 2004). This is most likely the case for the Helliwell System because the larger the tree is, the higher the score it will receive for this factor. A larger tree stands out more in an urban landscape than a small tree. The ‘size’ factor is also the only factor to have a possible score of over 4, so any large trees will yield a high product of the scores, even if they get low scores under the other factors. As previously mentioned, another issue is very small trees being given a score of 0 under the Helliwell System. This would suggest that very small, newly planted trees have no visual amenity value at all, which is untrue. Some people may find small, young trees visually attractive with the knowledge that someone is making the effort to actually plant new trees.

4.1.2 Tree Age

Similarly, visual amenity value increases as the age of the tree increases (see Figure 3.4). This may be because the older a tree is, the larger in size it is likely to be. These results suggest that we should be trying to maintain large, old trees rather than cutting them down to make space for new trees. Of course, large, mature trees are more likely to pose management issues and are not always suitable due to limited space and the potential to damage surrounding buildings and infrastructure (Vogt *et al.,* 2017). It is therefore important that these trees are managed correctly to ensure no incidents occur that would lead to the removal of the tree.

4.1.3 Tree Type

The tree type that had the highest mean visual amenity value per tree was Lime. Lime trees are also the most common tree seen across the South Parish, accounting for 21.6% of all the trees. The reason for this high visual amenity value may be because Lime trees grow to large sizes (making them more prominent in the landscape) and are long-lived (Eaton *et al.,* 2016). Apple, Sycamore, Whitebeam and Hornbeam trees also had high visual amenity values on average. On the other hand, trees such as Hazel, Myrtle, Cabbage Palm and Larch had very low average visual amenity values. However, this result may be misleading. There was only one Larch recorded in the entire Parish and it was only very recently planted, so it scored very little under the size factor. In a few years’ time this tree may have a much higher visual amenity value. Similarly, there were only 3 Myrtle trees and 3 Hazel trees recorded, so the mean visual amenity values for these species are not very representative due to such a small sample size.

4.1.4 Tree Location

South Terrace is the most valuable street in the South Parish in terms of total visual amenity of trees. This is probably because it contains so many trees (46) in comparison to other streets. All of these trees were either Hornbeam or Lime, which have been shown to have high visual amenity values. However, when looking at means, the trees on Sullivan's Quay outperform all other locations. Although there were only 11 trees here, on average they scored highly. All but one of these trees were Lime trees, many of which were large and of good form. These trees looked particularly suitable located just beside the river, which also accounted for their high monetary value.

Even though St. John's Cemetery contained many trees, they contributed very little to the total visual amenity value of the South Parish and the mean of the trees here was also very low. This is because most of the trees here were newly planted and therefore very small. They were considered to be less important than other trees in the South Parish because they are not seen by as many people as the street trees are. However, in a few years' time these trees will likely have higher visual amenity values when they have increased in size. This small green space is located within a residential area on Quaker Road and in time could potentially be highly valuable and a peaceful escape for locals from the busy urban life.

4.2. Carbon Sequestration and Storage

The estimated gross sequestration rate of the trees surveyed was low, showing that there are not enough trees in the South Parish to make much of a difference to offsetting national carbon emissions. This may be due to the fact that many trees found here were small, young trees, which are known to sequester less carbon than larger trees that are still growing (Stephenson *et al*., 2014). In 2015, the average CO_2 emissions per capita in Ireland was 13.2 tonnes, compared to the EU average of 8.8 tonnes (Cso.ie, 2019). This means all the trees in the South Parish are just enough to sequester one Irish person's annual carbon emissions (South Parish trees sequestering 15.68 metric tonnes per year). A similar study carried out in Mexico City found that urban greenery was unable to significantly offset anthropogenic carbon emissions, accounting for only about 2% of human activities in the area (Velasco *et* *al*., 2016). To offset the total carbon emissions in Mexico City for the year 2012, a forest 15 to 18 times the size of the city would be required.

Lime trees are the biggest contributor to carbon sequestration in the South Parish, not because Lime trees are better at this but only because they are the most abundant trees. Lime trees actually ranked poorly for both mean carbon storage per tree and mean carbon sequestration compared to other large stature trees. This result was similar to other studies which have shown that Lime trees are ranked as number 10 out of 12 large stature species for both carbon storage and sequestration (Hand *et al.,* 2019a).

As was expected, larger, mature trees sequester and store the most carbon on average. These results therefore indicate that large trees should be maintained rather than cutting them down and replacing them with smaller trees. Removing large trees would mean the release of the accumulated carbon into the atmosphere (Velasco *et al.,* 2016). Both Oak species and London Planes sequestered significant amounts of carbon based on the iTrees model. A number of studies have shown that Oak trees outcompete London Planes when it comes to both carbon storage and sequestration (Hand *et al*., 2019a, Hand and Doick, 2019). Horse Chestnut, another large stature tree, also performed very well in terms of carbon storage and sequestration. It is recommended that these trees are planted to help capture and store carbon. However, due to their large size, these trees may not be suited to small, narrow streets or close to buildings. This may explain why there are so few of these trees in the South Parish. Despite a history of their presence on city streets across the world, a study has shown that people perceive London Plane trees as unsuitable trees for streets, likely due to their large size (Fernandes *et al*., 2019). Large-stature trees may be better suited to urban parks and gardens.

It is clear from these results that to make a significant difference to reducing our carbon emissions, a lot more trees would be needed in the South Parish. This could be made difficult due to the many narrow streets and close proximity to buildings. However, there is potential for more trees to be planted and it should be encouraged. We also need to look at the bigger picture and consider planting more trees in the countryside where there is more space for large stature trees. Unfortunately, the planting of a few trees in the city alone will not be enough.

People often seem to rely on tropical forests to offset carbon emissions but this is no longer an option. A recent study has shown that tropical forests are losing the ability to sequester carbon. Tropical forests are now removing approximately one third less carbon than they did in the 1990s, dropping from 17% in the 1990s to about 6% in the 2010s (Hubau *et al.,* 2020). All countries need to play their part in reducing emissions. The Irish government's Climate Action Plan 2019 aims to plant an average of 8000 hectares of trees per year to tackle climate change. If successful, it would mean a significant change in the use of farm land in the country. Currently, the forest land cover in Ireland is 11% and the aim is to achieve the 18% land cover target by 2046 (Climate Action Plan 2019). This is an ambitious plan but not the total solution. City areas such as the South Parish should concentrate on reducing carbon emissions by spending money on improving public transport thereby encouraging people to drive less. The results of this project have shown that the number of trees in a typical urban setting is not enough to make a significant difference to reducing carbon emissions.

Importantly though, the case that urban trees are not capable of sequestering the abundance of CO^2 required to tackle climate change in isolation should not be an argument against them given the range of other benefits which urban trees provide in cities.

4.4. Future Research

In some ways, it may seem cold and heartless to put a monetary value on trees as we have done here using the Helliwell method, but it is necessary if we want to stress the importance of protecting and planting urban trees. Valuing trees in monetary terms may be more informative and useful for policy-makers. It is clear from the results presented here that urban trees do have a value but only three benefits (visual amenity; carbon storage and sequestration and insect biodiversity) were studied here. It is therefore recommended that future research examines further benefits such as filtration of pollutants, increasing other elements of biodiversity and reducing flooding to get the full value of these trees.

4.5. Key Recommendations and Conclusions

- Native trees represent a relatively small proportion of those planted in the South Parish. There is scope for new tree planting in the area to favour suitable native species.
- A large number of the most significant and prominent trees in the South Parish are mature. There is a need to provide new tree planting in both on-street and off-street locations in the South Parish to ensure continued and enhanced tree cover.
- These mature trees, however, make a large contribution to the aesthetic value and carbon storage benefits of the urban tree community. They need to be protected.
- The very significant role that educational, religious and institutional spaces play in providing green spaces and urban trees in the South Parish is recognised. For example, St. Finbarre's Cathedral, Nano Nagle Place, the Quaker Graveyard and St. Marie's of the Isle, etc. all have impressive, mature tree collections in their own right. Such green spaces need to be protected from future development.
- The role of urban trees in sequestering carbon; providing habitats for biodiversity; providing shade; reducing the impact of flooding events; etc. is highlighted in the report.
- The carbon storage and sequestration role of urban trees is relatively modest. That being said, the multitude of other benefits are enough, on their own, to make the case for urban trees.
- Further work is needed to understand the biodiversity impacts of urban trees.

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